URBAN/MUNICIPAL
CA3ON HW Q60
91 D367

Discussion Paper No.7

Environment and Health

Prepared for

The Regional Chairman's Task Force
on Sustainable Development

by

The Regional Municipality of Hamilton-Wentworth
Planning and Development Department
Regional Planning Branch

May 31, 1991

Acknowledgements

Although the preparation of this paper was undertaken through the Hamilton-Wentworth Planning and Development Department, Regional Planning Branch, large portions of the paper were prepared and/or edited by Dave Stieb of the Department of Public Health Services and Doug Sider of the McMaster Health of the Public Project. Their assistance is greatly appreciated.

Digitized by the Internet Archive
in 2024 with funding from
Hamilton Public Library

https://archive.org/details/discussionpapern07unse

Table of Contents

1 Introduction: What Are Environmental Health Hazards and How Can We Cope With Them? 1
- 1.1 Types of Environmental Health Threats 1
- 1.2 Means of Addressing Environmental Health Problems 1

2 The Historical and Institutional Context 3
- 2.1 Early Municipal Environmental Health Interventions 1850-1960 3
- 2.2 The Expanding Mandate of Provincial and Federal Governments 1960-1990 . . 4
- 2.3 The Present Regional Role in Environmental Health Issues 6
- 2.4 Pressures to Expand the Regional Role 8
- 2.5 The Concepts of Risk and "Acceptable Risk" in Environmental Policy Decisions 8
- 2.6 Limits of Epidemiology 10

3 Present Major Areas of Concern 12
- 3.1 Health Threats Present in the Air 12
  - 3.1.1 Outdoor Air 12
  - 3.1.2 Indoor Air 14
- 3.2 Health Threats Present in the Water 14
  - 3.2.1 Municipal Water from the Great Lakes 14
  - 3.2.2 Health Threats Present in Groundwater 16
  - 3.2.3 Other Health Threats Present in Water 17
- 3.3 Health Threats Present in/on the Ground 18
  - 3.3.1 Landfill and Contaminated Properties 18
  - 3.3.2 Health Threats Caused by Heavy Metals in the Environment 18
  - 3.3.3 Health Threats Caused by the Use of Pesticides and Herbicides 19
  - 3.3.4 Health Threats Found in Buildings 19
  - 3.3.5 Health Threats Present in Food 19
- 3.4 Health and the Physical Environment 20
  - 3.4.1 Radiation 20

4 Major Environmental Health Trends in the Region of Hamilton-Wentworth 22
- 4.1 Air Quality Trends 22
  - 4.1.1 Outdoor Air 22
  - 4.1.2 Trends in Indoor Air Quality 23
- 4.2 Water Quality Trends 23
  - 4.2.1 Surface Water Quality (Lake Ontario) 23
  - 4.2.2 Groundwater Quality 24
- 4.3 Trends in Threats from Contaminated Sites 25

5 Conclusions and Implications for the Future 27

Selected References 29

1.0 Introduction: What Are Environmental Health Hazards and How Can We Cope With Them?

1.1 Types of Environmental Health Threats

Since the beginning of recorded history, humans have faced innumerable threats to their well-being from the environment around them. Fire, floods, disease, cold, accidents, predators, and a host of other undesirable factors have threatened pain, injury and death. As a result, mankind has attempted to control the environment in an effort to eliminate or at least minimize these threats.

Environmental threats to human health have conventionally been broken down into four categories: biological, chemical, physical and psychological. Biological threats are caused by the effects of microorganisms or their toxins within the human body. Examples include communicable diseases such as intestinal parasites or cholera, mosquito-borne transmission of malaria, or toxic bites of snakes and spiders. Chemical threats result from chemical agents or compounds which may be man-made or may be naturally-occuring elements. Examples include nitrates and organic chemicals in drinking water. Chemicals can either cause direct toxic effects or can do damage to human beings by being carcinogenic (cancer-causing), mutagenic (damaging to genetic material) or teratogenic (damaging to the fetus). Physical threats are usually of an immediate character, often associated with easily identifiable events such as fires, natural disasters, or car crashes. Some physical threats, such as environmental radiation, are more long-term and less obvious. Psychological threats, although important, are often overlooked, and can affect the physical or mental health of a person. Examples include continuous exposure to loud noise, crowded urban environments lacking contact with nature, or forced isolation.

It should be noted that the real or potential effects of a number of current environmental concerns, such as global warming, depletion of the ozone layer, deforestation and desertification, cannot be easily characterized as being part of of one of the categories presented above. For example, global warming, through its capacity to change ocean levels, increase risks of drought and desertification, alter natural habitats, and affect agricultural productivity across vast geographic regions could produce a wide range of adverse health effects in specific parts of the world or across the whole globe. Ozone depletion, too, has the potential to cause a wide range of severe human health problems such as skin cancer and cataracts that are not easily characterized, particularly since the effects of increased ultraviolet radiation on human behavior and health, plant growth, food production and broader ecosystem functions is not well understood.

1.2 Means of Addressing Environmental Health Problems

Once an environmental health hazard has been identified there are numerous ways to minimize or potentially eliminate adverse health effects. Using the health threats posed by indoor tobacco smoke and other hazards as examples, the options include:

1. **Direct elimination of the problem**: Passing and enforcing legislation to ban smoking in public places such as offices, restaurants and plane flights, would eliminate public exposure to tobacco smoke. Provision of effective smoking cessation programmes for parents with children would eliminate childhood exposure in the home. Other examples of direct elimination of environmental health threats are chlorination of water to kill

bacteria; removal of lead from gasoline; use of pollution control devices on automobiles; or banning products such as chlorofluorocarbons (CFCs) or certain pesticides. One of the benefits of direct elimination is the prevention of not only human health effects but as well negative ecosystem effects (which in the case of CFCs and pesticides may be a more important "health" benefit than that experienced directly by humans).

2. **Indirect elimination of the source:** A variety of economic measures to reduce cigarette consumption such as taxation policy, agricultural substitution support, and banning tobacco advertising, would decrease the prevalence of smoking, and thus public exposure to tobacco smoke. Other examples are gasoline pricing strategies which penalize the use of leaded gasoline, or that increase the cost of automobile use to the point where public transit or car-pooling become preferred options. Again, both human health and ecosystem health would benefit from these actions.

3. **Isolation of, or protection from, the problem:** Non-smoking sections of restaurants, designated smoking sections for office buildings, improvements in building design and ventilation or parental smoking out-of-doors or in well-ventilated rooms seek to isolate the hazard (tobacco smoke) from potentially affected individuals (non-smokers). Other examples of this strategy include the removal of heavy industry from residential areas by land-use planning controls, and the removal of hazardous wastes to special storage sites far from highly populated areas. The alternative is to isolate potentially exposed individuals from the hazard. Examples of this approach include advising decreased physical activity at times of poor Air Quality Index readings, recommending that families with asthmatic children move from more polluted urban environments, or using personal protective equipment in a variety of occupational settings. The main drawback of these approaches is that the principal benefit sought is a human health one, with ongoing potential for damage to the broader ecosystem.

4. **Treatment for those developing health consequences**: In the case of indoor tobacco smoke, this would entail treating the short-term complications of exposure to second hand smoke such as childhood chest infections and asthma and accepting the long-term complications such as poorer childhood lung development and lung cancer and other cancers in adults. Many other environmental contaminants may also cause subtle, long-term damage such as lead and learning disorders, radon and lung cancer, air pollution and chronic lung disease, and pesticides or other chemicals and birth defects or infertility. Assuming a "treatment" orientation not only means that a certain burden of human health effects is considered inevitable but also translates into a failure to recognize and remediate the ecosystem damage which accompanies these human health consequences.

2.0 The Historical and Institutional Context

2.1 Early Municipal Environmental Health Interventions 1850-1960

Individuals today rarely think twice about basic services provided by local municipalities. We take it for granted that safe water will be provided to individual households at very low costs, that sewage will be disposed of in an efficient and sanitary manner, that basic levels of disease control will be maintained in local restaurants, and that new housing subdivisions will be planned to comfortably avoid sources of distress such as industrial pollution and overcrowding. To most people, these services are so basic as to be forgotten in the routines of their day-to-day lives.

Municipal services often remain forgotten until a local outbreak of a communicable disease takes place, until residents are made aware of a local industrial development that they percieve as a threat to their health or land-values, or until concerns spread that local drinking water is somehow tainted. Recent public concerns about issues such as the quality of drinking water, the spread of pesticides and industrial toxins into food, air and water, and the long-term side-effects of current waste management practices have served to refocus the general public's attention on municipal environmental health issues.

In fact, municipal government as we know it today was largely fashioned in the 1850 to 1930 period as a response to environmental health problems. It was municipal government, and its integral units now commonly referred to as the Health, Planning, Building and Engineering departments, that first tackled the most pressing environmental problems facing urban areas in North America and Western Europe in the late 19th and early 20th centuries. Engineering departments were created to provide potable water and sanitary sewers to every household, eliminate open sewers and build safe roads. Urban planning departments arose out of demands for a more reasonable and healthy separation of land-uses and for a more functional and aesthetically-pleasing physical environment. Health departments were created as the result of public outcry over the spread of cholera and other communicable diseases, often as the result of poor water quality, poor food preparation or unsanitary conditions in residential areas. Building departments evolved as municipalities sought to shut down some of the more appalling slum housing, and fire departments expanded as protection was demanded for people living in virtual fire-traps.

Hamilton was little different from other rapidly growing industrial towns in the 19th century in its early experiments with the provision of municipal services to reduce environmental threats to public health. It was the great cholera epidemics of the 1840s and 1850s that caused Hamilton's municipal administrators to first start a municipal dump, to study and then implement plans for a sophisticated water-supply system complete with a pump system, and a covered-sewerage network. At the time, the very heavy expenses were justified on the basis of public health concerns and as prerequisites for economic development. By the 1850s and 1860s municipalities were beginning to realize that a thriving city had to be able to maintain at least minimal standards of environmental health to attract prospective residents and businesses.

During the late 19th and early 20th centuries, municipal government functions were steadily surpassed in expenditures and importance by higher levels of government as social and economic planning began to eclipse health and urban planning as the major focus of public interest. Nonetheless, during the post-World War One era local governments continued to innovate and establish new programs and policies with regard to environmental health. Much of the work done in urban planning in Hamilton-Wentworth that has segregated new industrial uses from residential areas took place in the 1945 to 1975 period, and it has only been in the post-World War Two era that municipal government (the region) has made substantial progress in treating sanitary sewer wastes that are discharged into the harbour.

2.2 The Expanding Mandate of Provincial and Federal Governments 1960-1990

Less than a century ago the federal and provincial governments were relatively tiny organizations with extremely limited resources and powers. For the better part, pre-World War I government above the municipal level depended largely on customs, excise and special taxes for sustenance (income tax was a novelty) and limited its responsibilities to matters such as managing maritime trade, maintaining national defense and judicial systems, and keeping a post office operating. Things have clearly changed, however, and the provincial and federal governments now assume major responsibility for a number of important areas including environmental health.

Under Canadian constitutional agreements, the provinces have primary jurisdiction over environmental matters. In Ontario, the four major ministries active in the environmental health field are the Ministry of the Environment, the Ministry of Health, the Ministry of Natural Resources and the Ministry of Municipal Affairs. At the present time, these ministries act in two types of roles. Certain ministries, such as the Ministry of Municipal Affairs, primarily supervise and coordinate municipal efforts within their particular areas of concern, usually doing little more than providing grants to municipal organizations, providing research and direction, and changing the enabling legislation (see section 2.3) as required from time to time. Other ministries, such as the Ministry of the Environment and the Ministry of Natural Resources, tend to initiate and implement programs as well as alter relevant legislation and supervise municipal activities.

The Ministry of the Environment (MOE) is the most powerful provincial agency in this area, responsible for dealing with issues related to toxic real estate, emissions of dangerous compounds from industries, air quality, water quality both in natural water bodies and in raw and refined drinking water supplies, toxic waste management, environmental assessment, and pollution abatement programs. Both private corporations and municipalities now depend on this ministry for analytical expertise, testing capabilities, and provision of quality standards. Municipalities play a totally subservient role in this field. The MOE not only sets standards and enforces them, but is also responsible for administering new proactive abatement programs such as the Municipal and Industrial Strategy for Abatement (MISA). This ministry is the primary source of government expertise in areas such as site decommissioning, air and water quality analysis, and toxic waste management .

Over the past few decades the MOE has expanded to the point where it now employs more than 2,000 staff working in areas as diverse as pollution abatement, enforcement of existing legislation and directives, issuance of approvals, on-site testing, policy development, and laboratory research and modelling. At the present time the MOE enforces the Province's environmental policies through: control orders; licensing approvals; preventive, clean-up, and repair orders; stop orders; detention and removal orders; and restraining and prohibition orders. Until relatively recently, the Ministry of Health had limited its jurisdiction in areas of environmental health to communicable disease control. More recently, under the Health Protection and Promotion Act (1983) and the Mandatory Health Programs and Services Guidelines (1989), the Ministry of Health has assumed broader environmental health responsibilities including reducing or eliminating health hazards in general, reporting of environmental risk areas and investigating non-communicable disease outbreaks.

The Ministry of Natural Resources (MNR) plays an important but subsidiary role in addressing environmental health threats. The MNR has been primarily involved in creating management plans and carrying out policies in the areas of woodlot, wildlife and fishery conservation and/or harvesting. An important byproduct of these activities, however, has been the development of a wide range of expertise on biological and ecosystem issues, allowing it to play an important role in monitoring and evaluating the quality and quantity of land, air and water resources in any given area. The MNR is becoming increasingly involved in groundwater and surface water quality control, and employs numerous biologists and hydrologists, knowledgeable about groundwater contamination and surface water pollution issues.

In the past, the Ministry of Municipal Affairs has been implicitly involved with environmental health issues in the sense that urban planning has always been linked with environmental considerations such as "carrying-capacity" planning for communities, infrastructure provision (i.e. water and sewers), the physical separation of heavy industry from residential and institutional uses, and the control of housing densities (i.e. avoidance of overcrowding). It will probably soon become explicitly involved once the Province has completed a "green" revised version of the Planning Act. The Planning Act currently allows for land-use decisions based on drinking water and septic system pollution criteria as well as on other criteria related to environmental health.

The Ministry of Consumer and Commercial Relations, through its Fuel Safety Branch, also has an impact on certain environmental health issues. The Fuel Safety Branch is responsible for regulating the storage of fuel in above-ground and underground tanks which can corrode and release oil and gasoline into groundwater.

Two other provincial entities involved in the environmental health area are the Environmental Assessment Board and the Ontario Municipal Board. These two administrative tribunals make decisions that affect a number of environmental health issues. The location of landfills, the separation of land-uses, the safety of various types of development in proximity to neighboring communities, and the provision of government water and sewer infrastructure are examples of the types of issues that these boards deal with. In many cases, the decisions of the OMB or the EAB supplement Provincial policies in addressing environmental health issues.

The federal government has a relatively minor role in environmental health matters, since most urban, health, land-use matters and other environmental areas of concern are within provincial jurisdiction. The federal government has, however, played a role in environmental health matters for two reasons: firstly, it has a constitutional mandate in certain areas such as marine hospitals, international water management, international air quality management, and control over international fisheries as well as marine ports such as Hamilton Harbour; secondly, it has often used its powerful fiscal position to cooperate with provincial ministries by collecting and interpreting information related to epidemiological and environmental issues that the provinces could not afford to undertake on their own. Environment Canada and the federally-funded Canadian Centre for Inland Waters, for instance, have close ties with the Ontario Ministry of the Environment in the areas of analysis and management of water quality.

Current provincial and federal legislation that deals with environmental health issues is wide-ranging and difficult to summarize. Nonetheless, the most relevant legislation can be summarized as follows:

Primary Provincial Legislation: **Environmental Assessment Act, Environmental Protection Act, Ontario Water Resources Act**

Important Related Provincial Legislation: **Beach Protection Act**, **Dangerous Goods Transportation Act**, **Fire Marshal's Act**, **Gasoline Handling Act**, **Health Protection and Promotion Act**, **Municipal Act**, **Pesticides Act**, **Planning Act**, **Emergency Plans Act**, **Weed Control Act**, and **Pits and Quarry Act**

Relevant Federal Legislation: **Canadian Environmental Protection Act, Atomic Energy Control Act**, **Canada Water Act**, **Fisheries Act**, **Hazardous Product Act**, **Transportation of Dangerous Goods Act**, and **International Boundary Waters Treaty Act**

2.3 The Present Regional Role in Environmental Health Issues

The role of municipal government in environmental health and other areas is defined by the province. Municipal bodies are established by provincial enabling legislation which grants the municipalities the right to pass bylaws governing jurisdictions that under the Constitution belong to the province. Municipal administration of land-use planning policies, for example, must be sanctioned under the Province of Ontario's Planning Act. Thus, even when a town or city such as Hamilton undertakes basic forms of environmental health planning such as providing sewers and water services, permission has to be explicitly granted for this type of activity by an act of the Ontario Government.

At the present time, regional government is responsible for a wide range of activities that have a direct impact on public health in Hamilton-Wentworth. Regional environmental health activities can be summarized as follows:

Sanitary sewer infrastructure provision and sanitary sewer waste treatment and disposal: The Regional Engineering Department is responsible for providing sanitary sewer services to all areas in Hamilton-Wentworth within the urban boundaries as well as those areas for which there are pressing environmental concerns. Waste taken from these sanitary sewer lines is transported to the two regional sewage treatment plants, after which the treated waste is dumped into Hamilton Harbour or Cootes Paradise.

Water provision in urban areas: Raw water taken from intakes in Lake Ontario is transported into a treatment plant operated by the Regional Engineering Department, where it is treated to a point where it is suitable for human consumption. The treated water is then transported to households in urban areas throughout the region via a network of water mains and trunk lines operated by the Regional Engineering Department. Although the Ministry of the Environment sets basic standards and guidelines pertaining to municipal water treatment, the Engineering Department is responsible for the day-to-day affairs of the water treatment plant and the water provision network.

Testing of water in rural areas: The Regional Department of Public Health Services (DPHS) conducts testing of groundwater wells in rural areas on an as-needed basis. Although the DPHS tests primarily for bacterial contamination, testing for gasoline, nitrates or other toxic materials may also be conducted.

Testing of old dumps for leachates and management of operating landfill sites: The Regional Engineering Department tests old municipal landfill sites such as the Upper Ottawa Street site to ensure that toxins do not escape from the landfill. It is also oversees the management of current waste removal and landfilling activies at the Glanbrook site. Tricil, a private corporation, manages the day-to-day activities of landfill operations and many of the municipal solid-waste programs, although the Regional Engineering Department oversees all of the Tricil operations and makes all of the major decisions.

Operation of SWARU: Tricil, under the direction of Regional Engineering, also operates the Solid Waste Reduction Unit (SWARU), which produces electricity as a by product of waste incineration. Although the SWARU emissions are within the standards set by the Ministry of the Environment, residents in the area and local politicians have expressed concerns over public health effects from these emissions.

Prevention and Containment of Communicable Diseases: The Regional Department of Public Health Services is responsible for educational programs, inspection activities, and control of communicable disease outbreaks. Areas of particular concern are sexually-transmitted diseases, epidemics, and food and water borne diseases.

Prevention and Containment of General Environmental Health Threats: The DPHS investigates any potential threat to the health of the general population including investigation of complaints related to poor indoor air quality, noxious emissions from industrial or agricultural activities that are adjacent to residential areas, potential threats from explosions, illegal-dumping of chemical wastes, and potential health hazards in apartment complexes. In many of these situations, the DPHS works cooperatively with other agencies such as the Ministry of Labour, the Ministry of the Environment, or the local Fire Department or Building Department.

Preparation and Implementation of Public Mass Transportation Plans, and Plans for Major Transportation Infrastructure: The region, through its Engineering Department, Planning Department, and the Hamilton Street Railway, determines the location of new roads, the type of transportation utilized within the region, and the nature of future transportation priorities. From an environmental health perspective, these responsibilites have an impact on three major areas: air quality, energy consumption and deaths from accidents. Air pollution has increasingly become a problem directly related to automobile use. Any reduction in automobile use should contribute to a substantial decline in air pollution-related health problems. Similarly, reduced automobile use would result in a significant reduction in energy consumption. It could also translate into a reduction in deaths and injuries caused by motor vehicle accidents.

Emergency Preparation and Response: The Regional Emergency Control Group is the region's emergency response unit and is comprised of the Chief Administrative Officer (CAO) of the region, the Mayor and CAO of the affected area municipality, the Regional Fire Co-ordinator, the Regional Chief of Police, the Medical Officer of Health, and the Regional Commissioners of Engineering, Social Services, Transportation Services and Legal Services. This group coordinates public sector responses to emergencies in Hamilton-Wentworth. The region is also involved in the Community Awareness and Emergency Response Group (CAER), which is a voluntary group comprised of industry and government representatives that meets to coordinate activities that are related to emergency prevention and response. The Medical Officer of Health also advises on or issues orders for evacuation under the Regional Emergency Measures Plan.

Land-Use Planning and Related Environmental Issues: Present-day planning concerns related to environmental health include the enforcement of lot-size requirements in relation to the carrying capacity of soils (septic systems), the implementation of segregation regulations for industries utilising dangerous chemicals or explosives, and the preservation of enough natural greenspace to recharge existing groundwater wells.

2.4 Pressures to Expand the Regional Role

Over the past decade the general public has become increasingly aware of environmental health issues and is now demanding more substantial commitments from regional and local governments to try to clean up the environment and safeguard public health. These concerns and pressures are manifested in the current debates about the safety of municipal drinking water and the alternative use of bottled water, in the current drive to reduce garbage production and increase recycling, and in the increased awareness of environmental disasters such as the Elmira water contamination situation and the Hagersville tire fire.

The provincial government has also exerted pressure on municpal governments to increase their activity in the environmental field. In response to public concern about environmental issues the province has attempted to shift certain responsibilities to the municipal level. In some cases the province forces municipalities to shoulder new responsibilities legislatively, while in other cases moral suasion is used to ensure compliance. The Ministry of Health's recent guideline requiring that municipal medical officers of health compile a list of potentially contaminated sites and other environmental hazards, and the Ministry of the Environment's increasingly stringent pollution-control requirements pertaining to municipal sewage treatment plants are examples of these provincial efforts.

Examples of more cooperative initiatives include the introduction of the Municipal-Industrial Strategy for Abatement (MISA) pilot program in Hamilton-Wentworth and the introduction of a special amendment into the City of Hamilton's Official Plan requiring that the Ministry of the Environment be consulted when possibly contaminated properties are proposed as redevelopment sites. In some cases the province provides extra funding to match or supplement municipal costs imposed by the more extensive provincially-initiated programs or regulations, while in others the province expects the municipality to bear the costs of these additional responsibilities.

Individual municipal departments are becoming increasingly preoccupied with environmental health issues. Regional Engineering, for example, has become involved with more pollution control issues since the implementation of the pilot MISA program in Hamilton-Wentworth. As a result, it has increased its sewer-use monitoring in an effort to track down industries that illegally dump chemicals into the municipal wastewater system. The City of Hamilton's Real Estate and Legal Services Departments are now far more cautious about buying properties that may be contaminated because of recent experiences with the purchase of toxic real estate.

Regional Council has approved in principle the establishment of a Regional Environmental Office to coordinate regional policy and departmental efforts to address environmental health concerns. The Regional Environmental Office will, if funded, provide leadership in addressing regional concerns about toxic real estate, groundwater contamination and other types of ongoing pollution.

2.5 The Concepts of Risk and "Acceptable Risk" in Environmental Policy Decisions

"Risk" is a potential threat to well-being. It represents the probability of an outcome occurring in relation to some previous exposure, and is usually expressed in numerical terms such as percentages or ratios. Risks may be determined based on actual human experience, for example by direct measurement of the percentage of workers who develop lung cancer as a result of occupational exposure to asbestos or the rate of fatal traffic accidents per kilometre driven. When direct measurement of risk is not possible, less accurate means may be used. Examples of less direct approaches include estimating the risks of low level exposure to toxic materials based on the risks of higher occupational exposures, or estimating human risks based on animal or biological experiments.

Many people believe that we are now exposed to many more "risks" than ever before, particularly in relation to environmental hazards. With this awarenes comes a natural desire to eliminate risk altogether - the "zero risk society". While this idea is appealing, the innate mortality of human beings makes life a risky proposition and means that "safety" is never complete; nothing that we are exposed to truly carries with it a zero risk. Thus the question arises, how much risk are we willing to tolerate ? Voluntary risks no matter how large, such as those associated with skydiving or driving a car are generally considered tolerable because the individual assuming the risk has presumably decided that the benefits are worth the risks. However, involuntary risks, no matter how small, such as those associated with small quantities of industrial chemicals in drinking water, are often not considered tolerable because affected individuals have not directly agreed that the benefits received are worth the risks.

The relative distribution of risks and benefits is important as well; how much risk is tolerable depends on who assumes the risks and who reaps the benefits. Often the distribution is not equitable. Just as the benefits of twentieth century technology tend to accrue disproportionately to the rich, the risks tend to fall upon the poor. This inequity results in a predictable mistrust of assurances of "acceptable risk" handed down from above. In essence, **you** cannot decide how much risk I should tolerate; experts in isolation cannot determine public standards of safety and risk. At the same time the public cannot divest itself of responsibility for making these decisions. Meaningful decisions about the level of risk acceptable to the public must by definition be made with public participation.

A dilemma arises when one compares the "expert's" and the "lay public's" perceptions of risk. Notwithstanding the uncertainty in estimating risks, experts' perceptions of risk usually have the veneer of objectivity and precision. The general public's perceptions of risk, on the other hand, are often considered "emotional" or "uninformed", and are much at variance with expert opinion. Characteristics which may heighten public risk perception include:

- involuntary vs. voluntary exposure
- artificial vs. natural factors
- undetectable vs. detectable risks
- risks beyond personal control vs. within personal control
- unfamiliar vs. familiar
- uncertain vs. certain.

An underlying assumption is that community concerns and anxiety associated with risks of environmental exposure principally arise from a lack of the relevant, objective data on risks they actually face. However, perception of risk may not always be amenable to the provision of scientific data on its actual magnitude in comparison to other risks. A growing challenge facing people working within the field of environmental health (health providers, engineers, scientists, environmentalists, bureaucrats, politicians) is to establish effective processes to integrate estimations of objective reality, uncertainty and popular perceptions to determine priorities for environmental health actions, research, technical interventions, legislation, public education and economic planning.

The costs that can be exacted from a society because of misconceptions about relative risks can be quite substantial. Public opinion can force governments to direct financial resources to deal with minor problems while major problems go unnoticed, effectively creating a substantial "opportunity cost". As a recent article in the Economist pointed out:

> "Familiar risks are less frightening than the unfamiliar; invisible risks more scary than visible. Munching a peanut-butter sandwich seems safer than eating an apple sprayed with a pesticide such as Alar, although actually the sandwich contains 100 times more carcinogens than have been sprayed on the apple... William Reilly, the [American] Environmental Protection Agency, wants a public debate on green priorities. These are mainly imposed on him by Congress, which expects the EPA to devote more than a third of its budget to cleaning up hazardous-waste dumps. Yet two scientific reports have told the EPA that such sites should have lower priority than other environmental problems, including radon and threats to wildlife habitats, which voters care less about. Radon, a natural but carcinogenic gas, endangers the health of far more people; habitat destruction is more difficult to reverse" ("Green Choices, Hard Choices", Economist, March 16th, 1991, p. 11)

These types of potential pitfalls in policy-making exist at the regional level as well as at the federal and provincial levels. Decisions will have to be made regarding the allocation of limited financial resources to such different types of environmental health programs as groundwater testing, sewage disposal processes, reduction of incineration of municipal waste, solid-waste-reduction educational programs, toxic real estate and leaking fuel tank identification. Politicians and the general public must be provided with as much pertinent information as possible on what is known and is not known about both the most publicized and the most dangerous environmental health threats.

2.6 Limits of Epidemiology

Epidemiology is the study of the distribution and causes of both disease and health-related states. Epidemiologists use different types of studies to determine the causes of diseases or health problems and to evaluate the effectiveness of prevention and treatment programs. In the field of environmental health, activity centres around determining what people are exposed to, measuring the exposures, and relating them to possible health outcomes. Examples include studies examining the effects of air pollution on lung problems such as asthma, the effects of pesticides in food on childhood cancer, and the relationship between radon gas in homes and lung cancer.

Determining what people are exposed to is extremely difficult when there are many environmental agents which could cause disease - thousands upon thousands of chemicals in our air, water, food and land; biological agents such as bacteria, viruses, molds and fungi; and physical agents such as radiation, noise, heat and cold. Only a small fraction of these agents are presently measured and an even smaller fraction are well understood in terms of their effects on health.

Measuring these exposures is also difficult. Rather than being exposed to single agents, present in easily detectable quanitites, people are generally exposed to minute quantities of multiple agents acting in combination. We have virtually no knowledge as to the range of interactions that could occur between the numerous contaminants in air, water and food, especially those situations where possible damaging effects of one substance are either counteracted or augmented by another substance(s). An example of this type of interaction is the heightened lung cancer causing effect of smoking combined with asbestos or radon exposure.

Relating these agents to health outcomes is also complex. Often the possible outcomes, such as cancers or other chronic disease, are far removed in time or space from the exposure(s). Cancers, for example, often take 20 to 30 years to develop. Other outcomes are problematic as well. Clusters of common events such as birth defects, miscarriages, or cancers in a particular neighbourhood or geographic area are often perceived as the outcome of exposure to an environmental hazard when in fact they are often strictly chance occurrences, consistent with the overall prevalence of these disorders in the population.

In short, it is extremely difficult to determine how much of which contaminant is causing what human health problem. Although expanded resources and innovation may help to deal with many insufficiencies, the process is likely to be slow, uneven and as likely to introduce uncertainty as clarity. Different sectors of society can be expected to respond to this uncertainty in different ways. Industries such as tobacco or asbestos companies may exaggerate the uncertainty surrounding scientific evidence which links their products with adverse health effects in order to downplay the apparent risks. On the other hand (as noted earlier), uncertainty tends to heighten the public's perception of the risks associated with specific environmental exposures. The availability of definitive answers on human health effects will certainly lag behind the growing number of questions.

The availability of these answers will also lag behind the availability of evidence linking environmental contaminants with ecosystem damage (damage to plants, animals and their natural environment). Low-level chemical contamination of the Great Lakes, for example, has been linked to effects on fish and birds without as yet being convincingly linked to human health effects. Ecosystem damage of this sort not only signals the possibility of latent human health effects but also indirectly affects humans by damaging the natural resource base which is required for human survival. Beyond pure self-interest, humans also have a moral responsibility for environmental stewardship, to recognize and remediate the ecological effects of human activity. Thus, information on ecosystem effects must supplement information on human health effects in establishing environmental health priorities.

3.0 Present Major Areas of Concern

3.1 Health Threats Present in the Air

3.1.1 Outdoor Air

The air surrounding us, whether outside or inside of our living spaces, has been characterized as a "chemical stew". Air pollutants can have a variety of both natural sources (rocks, soil, volcanoes, fires and swamps) and man-made sources (combustion of fossil fuels and other material, transportation, industrial processes, and pesticide and fertilizer use). Pollution from man-made sources has been the usual focus of public concern. In addition, because air pollutants can contaminate the food chain and water supplies, people can be exposed not only by breathing pollutants in, but by eating and drinking.

Within Hamilton-Wentworth (and across the province) the most commonly measured air pollutants are total suspended particulate matter (TSP), sulphur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2) and ozone (O3). These pollutants are regularly measured and combined into the Air Quality Index (AQI). The Ministry of the Environment also regularly reports on air fluoride levels. Levels permitted for each of these pollutants have been established by the MOE "based on known effects on health, quality of life, sensitive vegetation or materials, whichever is most stringent" (1988 Hamilton-Wentworth Air Quality). Measurement and monitoring of these pollutants is done via a number of monitoring stations, sited in areas where it is suspected that higher pollution levels exist; the logic being that acceptable levels at these sites imply acceptable levels of pollution elsewhere.

While it is important to measure and report the AQI (higher, unacceptable levels lead to measures to both decrease production of pollutants at their sources: industry and vehicles use; and decrease exposure to pollutants of those most vulnerable to their effects: the young, old and people with respiratory problems) there is good evidence to indicate that AQI consistently underestimates the amount of pollution that individuals actually inhale. This has been shown by comparing air pollution levels measured at monitoring stations with those measured at the level of the individual with either personal monitoring or indoor air pollution measurements.

In addition, the AQI does not measure a much-wider variety of health-damaging pollutants: metals (mercury, cadmium, chromium, lead and arsenic), hydrocarbons (polyaromatic hydrocarbons (PAHs), methane, benzene and methyl chloride), photochemical oxidants (important components of urban "smog", whose proxy measure is O3 levels), PCBs, dioxins, furans, asbestos and others. For a fuller description of these pollutants, and the range of human and environmental health effects they do or could have, see Air Pollution and Human Cancer.

Health Effects Associated With Outdoor Air Pollution

Short Term Effects

Skin and eye irritation can be caused by a number of air pollutants, most notably ozone, SO2 and NO2. Of more concern are the respiratory effects of pollution, which have been well-examined in Hamilton children over the past 10-12 years. The principal conclusion from these studies is that air pollution "has much less effect" on children's lung function than exposure to cigarette smoke. This air pollution effect (specifically SO2 and fine suspended particulate material) is, however, of importance in children with asthma.

Ozone is another potent lung irritant, especially when acting in conjunction with SO2 and other sulphur compounds during temperature inversions in the summer months. Once again, the effect is much more pronounced in children and adults with asthma, especially when working or exercising out-of-doors. Increased rates of hospital admission due to respiratory problems and increased respiratory mortality rates have been related to the combined effect of hot weather and increased sulfate and O3 levels. It is hypothesized that O3 may make people more susceptible to the effects of airborne allergy-provoking substances or sulphuric acid (formed when O3 and SO4 levels are high).

Further indirect evidence of air pollution effects comes from the lower rate of lung disease and respiratory symptoms in rural vs. urban populations (although some of this difference can be accounted for by differences in smoking rates and occupational exposure to pollutants). Much research is presently being undertaken into the effects of acid aerosols (produced by atmospheric chemical reactions between sulphur compounds and other components) on lung function and respiratory diseases.

Long Term Effects

Links between air pollution and cancer are complex. Air pollutants may cause cancer directly (eg. direct effects of chemicals on human cells) or indirectly (eg. depleting the ozone layer, leading to increased skin cancer from increased exposure to ultraviolet radiation). Links between air pollution and lung cancer have been most intensively studied. The authors of Air Pollution and Human Cancer conclude that urban air pollution and exposures to certain types of industrial emissions may increase the risk of lung cancer, even when one takes into account exposure to tobacco smoke and occupational exposure to cancer-causing substances. It is estimated that air pollution could be causing a 5-20% excess of lung cancer in urban compared to rural areas. A study published in 1988 on lung cancer deaths in Hamilton between 1972-76 showed a slight increase in deaths in the more heavily industrialized parts of the city when age, smoking history and estimates of occupational exposure were taken into account. However, the elevated rate of cancer deaths could have been a chance occurrence, unrelated to exposure to air pollutants (the results were not "statistically significant"). The effects of urban air pollution on other types of cancer cannot be assessed with the evidence presently available. Since two to three decades usually pass between exposure to carcinogens and the development of cancer, we may be seeing the effects of past, and not present, levels of pollution.

It is important to recognize that both the sources and effects of air pollution have transnational and global dimensions. A considerable proportion of the air pollutants present in the region (eg. acid gases) have been transported here from industrial areas of the U.S. and contribute to air pollution related health problems in the region. At the same time, Hamilton-Wentworth contributes significantly to the global burden of air pollutants such as greenhouse gases, which have been linked to global atmospheric warming, and substances which deplete the stratospheric ozone layer, especially chlorofluorocarbons (CFCs). The health, social and economic consequences of these global effects could be massive, and far outweigh the local health impacts of regionally produced air pollutants.

3.1.2 Indoor Air

There is strong and growing evidence that indoor air pollution poses significantly greater health risks than does outdoor air pollution. Indoor air pollutants include tobacco smoke and a wide range of biological contaminants (fungi, molds, mites and bacteria), chemicals (CO, NO2, formaldehyde and hydrocarbons), and physical agents (radon and asbestos), often present at much higher concentrations than found outdoors. Such pollutants can come from a wide variety of sources - heating, cooking, cleaning, furniture and building materials. Legislation, regulation and monitoring exist for outdoor air pollutants but not for most situations where indoor exposure occurs.

Tobacco smoke is the single most important indoor air pollutant. Exposure (either directly via smoking or indirectly via sidestream smoke emitted by cigarettes or exhaled by the smoker) is associated with both acute and chronic health problems. Infants and children are especially vulnerable to passive exposure, suffering more respiratory symptoms, illnesses and hospitalizations, and poorer lung development. The U.S. Environmental Protection Agency has estimated that passive smoking causes as many cancer deaths as air pollution. Although the public health impact of indoor air pollution is at least as important as that of outdoor air pollution, typical outdoor air pollution control measures, involving both monitoring and abatement, are much less feasible when addressing the issue of indoor air pollution. A broader range of preventive actions including building and home design modifications, standards for building/dwelling use and ventilation as well as fiscal, legislative and public health measures aimed at reduction or elimination of smoking, are essential components of a strategy to reduce exposure to indoor pollutants.

3.2 Health Threats Present in the Water

Citizens of the region obtain their drinking water from three principal sources: (1) the regional water treatment and distribution system drawing from Lake Ontario; (2) communal wells; and (3) private wells. While the vast majority of the region's population depends on Lake Ontario water, it has been estimated that over 12,600 private wells exist in the rural zones.

3.2.1 Municipal Water from the Great Lakes

Pollution of the Great Lakes has been a long-standing international concern, with jurisdiction over this issue resting with the federal Government, the International Joint Commission, and the conservation authorities. Public concern about toxic contaminants in drinking water is reflected by the extent to which people have begun to use home-based filtration systems or bottled water to supposedly minimize or prevent exposure. (See, for example The Quality of Drinking Water in Toronto, City of Toronto Department of Public Health, 1990).

A wide variety of contaminants of suspected or proven toxicity is found in both Lake Ontario and Hamilton Harbour. These have resulted from decades of direct industrial and municipal discharges, agricultural run-off into the streams and creeks draining into these bodies of water, deposition from air pollution and other forms of pollutant transport from more distant sites of production, use or storage (eg. Niagara River contamination from the Love Canal and other sites). Although Hamilton Harbour has suffered marked contamination over the past decades, its influence on the overall quality of Great Lakes drinking water is negligible.

Contaminants can be divided into two broad categories: excessive nutrients and toxic materials. Examples of excessive nutrient loads are phosphorous and nitrates/nitrites. Toxic materials consist of a wide range of contaminants including pesticides, chlorobenzenes, dioxins, furans, PCBs, cyanide, ammonia, phenols and metals such as mercury, iron and zinc. Treating water to bring it within water quality guidelines in itself contributes to concern because of the production of trihalomethanes (produced by the interaction of chlorine and organic substances) and an increase in aluminum concentration during the treatment process.

The principal human health risks from toxic contaminants in water arise from: (i) insufficient removal during water treatment processes with resultant ingestion; (ii) consumption of foodstuffs which have bioconcentrated toxins, especially sporting fish caught in the lake or harbour (Published bans or restrictions on sport fish consumption attempt to ensure that exposure is within acceptable limits.); and (iii) contact via recreational activities, especially swimming.

Succinctly listing the specific health effects of each of the multitude of substances found in minute quantities in treated drinking water would be impossible. They would include possible linkages between aluminum and Alzheimer's Disease, trihalomethanes and cancer, lead and childhood learning and behavioural disorders and pesticides and cancer or birth deformities. Increases in the technical capacity to measure contaminants in concentrations of "parts per billion" (one thousand million) are increasing our recognition of both the extent of contamination and the uncertainty surrounding the health significance of minute levels of contamination.

While human health effects from chemical contamination of the Great Lakes have not yet been documented conclusively, there is evidence that various species of wildlife have been affected. High levels of a number of chemicals have been measured in birds and fish around the Great Lakes. These levels have been linked to reproductive and other health problems in these animals.

Hence, a number of themes will probably characterize future debates over the safety of drinking water obtained from the Great Lakes:

(1) pressures for zero toxic discharge into the lakes;
(2) investigation of costs and benefits of alternative water treatment schemes, especially those involving processes such as ozonation, carbon activation and reverse osmosis;
(3) better characterization and measurement of Great Lakes contaminants, especially the extent to which populations are being exposed to multiple contaminants with potentially important interactions;
(4) greater attention in policy development to evidence that fish and other wildlife have been affected by contamination;
(5) improved linkages with health outcomes data bases to try to refine understanding of possible relations between exposures and adverse health outcomes (especially those outcomes such as cancer which may appear decades after exposure); and
(6) improved communication of risks associated with drinking water supplies and broader involvement of the public in priority setting pertaining to treatment of water supplies and prevention of further contamination.

For a fuller understanding of the dimensions of this issue, one should refer to the State of the Environment 1990.

3.2.2 Health Threats Present in Groundwater

Although it shares some sources of contamination with municipal surface water, there are several problems which are unique to groundwater. Some of these are strictly aesthetic (pertaining to water taste or appearance) and these will not be considered here. There are a few problems which have confirmed or suspected health effects. In general the most important of these as determined by the frequency of occurrence and potential severity of health effects are: microbial contamination, radon, nitrates, organic chemicals including gasoline, and sodium.

Microbial Contamination

Bacteria, viruses and protozoa are microorganisms which are widespread in nature. Many of these organisms are present normally in the human body and actually contribute to our well-being. However some of them cause disease. Contamination of drinking water with disease-causing microorganisms has traditionally been considered the most important drinking water contamination issue because of the relationship between some of these microorganisms and epidemics of water-borne diseases such as cholera and typhoid fever. With the advent of modern sanitation, in particular the disinfection of drinking water by chlorination, the spread of water-borne disease has declined dramatically.

Groundwater, however, whether it comes from a private well or a community well is usually not routinely chlorinated and microbial contamination may occur. Contamination is usually the result of septic system overflow or runoff from animal waste into groundwater wells. Wells are more likely to become contaminated if they are old, shallow-dug rather than drilled, or otherwise poorly protected from contamination with surface water. Droughts, windstorms, flooding and spring thaws can also contaminate well water with surface water. When health effects occur from microbial contamination of groundwater, they are most often gastrointestinal, such as stomach cramps or diarrhea.

It is generally not practical to test well water for all of the different types of organisms mentioned. However, it is possible to test for particular types of bacteria, fecal coliforms, which are a relatively reliable indicator of recent contamination of water by human or other animal wastes. If problems with microbial contamination of well water arise, determination of the cause and appropriate water treatment are necessary.

Radon

See section 3.5.1.

Nitrates

Nitrates are chemicals found commonly in well water from farming areas. Nitrates often come from farming sources such as nitrogen fertilizers and animal manure. They can also originate from leaking septic tanks or beds, and the breakdown of organic materials in the soil. Nitrate contamination often arises from the same sources as microbial contamination.

High levels of nitrates in drinking water cause methemoglobinemia in infants. This is a rare but potentially fatal condition which affects the ability of blood to carry oxygen. Infants are at much higher risk for this condition than adults because they lack the enzymes which protect them against methemoglobinemia. The main risk to infants relates to feeding with formula prepared with nitrate-contaminated water. Diarrhea can put infants at even greater risk of developing this condition.

There is some very weak evidence to suggest that nitrates are associated with a greater risk of gastrointestinal cancer. However the contribution of well water relative to other dietary sources is probably quite small.

Nitrate contamination necessitates identification of the cause and use of an alternate drinking water supply until the problem is remedied.

Organic Chemicals

Organic chemicals are derived from carbon and include substances like solvents and alcohols. There are literally thousands of organic chemicals in use in industry and homes, many with unknown health effects. The main sources of these chemicals with respect to drinking water are industrial and municipal discharges, agricultural runoff, and decomposition of natural materials. Other sources include landfill leachate, accidental spills and leaking underground storage. Some organic compounds can also appear in municipal water as a result of chlorination in the treatment process. (See section 3.2.1.)

One of the greatest potential problems is the contamination of wells with gasoline which has leaked from damaged storage tanks. Hazards include explosions from vapour trapped in basements and possible (but as yet unknown) acute and chronic health effects from ingestion of contaminated water and inhalation of fumes. Contamination is complicated by the fact that once present in groundwater, gasoline is usually very difficult to remove. Records of the whereabouts of these tanks, kept by the Fuel Safety Branch of the Ministry of Consumer and Commercial Relations, probably underestimate the potential magnitude of the problem. Many old, deteriorating tanks, particularly in rural areas, may not be on record with the ministry.

Sodium

Sodium is a common element throughout the natural environment. Levels in drinking water may be increased by geologic sources, water softeners, runoff from road salting and low water levels which make the sodium more concentrated.

Health effects from sodium in drinking water are unlikely in otherwise healthy individuals. Some sodium is in fact essential for human life. The amount of sodium that most people consume as part of their daily diet (naturally present in food or added as table salt or during food processing) is usually much greater than the amount present in drinking water. However, if the level of sodium in drinking water is unusually high, it may be more than is desirable for individuals who are on low salt diets for medical reasons. Regular water testing and water treatment are usually adequate in this situation.

3.2.3 Other Health Threats Present in Water

Swimming or bathing in Hamilton Harbour and along Regional beaches on Lake Ontario is associated with a much greater risk from bacteriological contamination than from toxic chemicals and metals. Bacterial contamination could present a variety of acute health risks -

gastrointestinal infections from ingestion of contaminated water and superficial infection of the skin, eyes or mucous membranes.

3.3 Health Threats Present in/on the Ground

3.3.1 Landfill and Contaminated Properties

Concerns regarding health underlie much of the public's concern about landfill sites and other contaminated properties. A number of health studies have been undertaken in Canada and the United States but the huge range of possible contaminants combined with a general lack of specific knowledge of the contaminants at a particular site makes it difficult to draw any consistent conclusions about the nature of any health effects from these facilities. This is complicated by the employment of generally weak research methods. One of the principal issues relates to distinguishing between effects which are actually caused by physical exposure (i.e. through inhalation of fumes or dust, direct contact with skin, or ingestion of materials) and those which are caused by worrying about exposure. (See also section 2.6 on this point.)

There appears to be a large potential for exposure of the general public to past and present dumpsites containing a whole array of chemicals with essentially unknown health effects. A number of instances of drinking water contamination from these sites have been reported, although cause and effect relationships between exposure and health effects have not been consistently demonstrated. Whether effects are psychosocial or physical, the health of the general public will be best served by reduction of the amount of waste generated, improved safety of disposal and thorough monitoring of potential exposure, particularly with regard to monitoring ground and surface water quality in the vicinity of dumpsites.

There are a few substances which are of greatest priority from the point of view of potential health effects: heavy metals, radioactive materials and organic chemicals. (Radioactive materials and organic chemicals are considered in sections 3.5.1 and 3.2.2 respectively.)

3.3.2 Health Threats Caused by Heavy Metals in the Environment

Lead

Lead is a naturally occurring metal with many industrial uses. There are two main classes of lead - organic (lead in combination with organic compounds containing carbon) and inorganic (not containing organic compounds). Organic lead (organolead) compounds have had their main applications in gasoline as antiknock compounds, although these have recently been removed from the market in Canada. Exposure to organolead compounds in the past occurred mainly through airborne exposure from vehicle exhaust. This constituted one of the greatest sources of lead exposure for the general public prior to the removal of these compounds from gasoline. The largest source of exposure for most individuals at present is lead naturally present in food. Drinking water (from lead solder used in plumbing) and contaminated soil are other possible sources. Children are particularly at risk becuase they are more physiologically susceptible and because they are more likely to ingest contaminated soil.

It is clear that very high levels of lead in the blood (often from acute exposure) cause severe health effects in relation to the gastrointestinal system, the blood, the kidneys and the central nervous system. In addition, there is now good evidence that there may be subtle mental effects in children from low level exposures which were previously thought to be safe. Simple measures such as running water to remove overnight lead accumulation are probably quite effective in reducing exposure from drinking water. Soil contamination is a much more complex problem which requires monitoring of safe disposal practices for industries using and disposing of lead.

Mercury

Mercury is a naturally occurring metal which is also widely used in industry. It too exists in organic and inorganic forms. Industrial discharges containing organomercury compounds were responsible for widely publicized outbreaks of mercury poisoning in fish eaters in Japan (Minamata Bay) and areas of Northern Ontario. Inorganic mercury appears in batteries, instruments such as thermometers and dental amalgam. The main source of non-industrial soil contamination with mercury is disposal of household batteries. Both acute and chronic health effects of mercury exposure are clearly recognized with regard to the central nervous system and the kidneys.

3.3.3 Health Threats Caused by the Use of Pesticides and Herbicides

Agricultural pesticides and herbicides are a concern in rural areas of the region. Runoff from field applications has been shown to contaminate nearby surface water, and is implicated in the contamination of groundwater. It now appears that long term (several years or more) residues of the newer pesticide products are not a major problem. There is, however, an increasing amount of concern over the use of urban herbicides such as 2,4,-D, which are sprayed on lawns to reduce or eliminate weed growth, and over the use of household termite and cockroach control chemicals that may accumulate in residential structures and affect human health.

3.3.4 Health Threats Found in Buildings

Buildings often contain construction materials that could at some point in their lifetime pose a danger to humans. Examples include the use of asbestos for fire protection and the use of lead as solder in plumbing. Both release materials over time that could have serious health effects.

3.3.5 Health Threats Present in Food

Food production, distribution, processing, preparation and consumption form an important part of our environment. Most experts in food safety and nutrition rank the risks associated with the food we eat in the following order: microbial contaminants, nutritional imbalances, environmental contamination, toxic substances which occur naturally, pesticides and food additives. In the United States, microbial contaminants, principally a wide variety of bacteria and fungal toxins, are estimated to cause tens of millions of cases of food-borne illness each year, with over 9000 deaths.

On the other hand, public concerns rank pesticides, animal drugs and antibiotics and food additives at the top of the list. In 1981, in a widely quoted study entitled The Causes of Cancer, Richard Doll and Richard Peto estimated that 30-60% of cancers are related to diet. This is not simply due to cancer-causing substances in foods, but relates to such dietary issues as consumption of high fat diets (bowel and breast cancer), red meat, and diets low in natural fibre (bowel cancer). However, estimates of the sources of carcinogens in typical diets suggest that 98% are naturally occurring substances in basic foods such as grains, fruits, vegetables and meats. Cooking meats, especially broiling, charbroiling and smoking, leads to exposure to such carcinogens as polyaromatic hydrocarbons (PAHs) (especially benzo-(a)-pyrene), amines and nitrosamines. A further 1% of dietary carcinogens come from spices and flavours such as mustard, pepper, cinnamon and vanilla.

Dietary cancer risks that most concern the public make up a fraction of the remaining one percent, eg. additives .2% and pesticide residues .02%.

3.4 Health and the Physical Environment

There is a range of health effects caused by extremes of heat (dehydration, heat stroke, aggravation of existing heart and kidney problems) and cold (frostbite, hypothermia). Ambient noise from industry, auto and truck transportation and airports can also produce physical and psychological health problems. One of the most significant types of physical threat, aside from accidents and natural disasters, is radiation.

3.4.1 Radiation

Radiation occurs in two forms, ionizing and non-ionizing. Ionizing radiation is high in energy and includes sources such as x-rays and naturally ocurring radioactive materials like radium and uranium. Non-ionizing radiation is lower in energy and includes ultraviolet rays from the sun, visible light, infrared rays (heat), and microwave and radiofrequency radiation. In general, higher energy ionizing radiation is associated with more acute and serious health effects, compared to non-ionizing radiation. It should be borne in mind that humans have evolved in the presence of naturally occurring radiation.

Ionizing Radiation

The main source of this type of radiation, excluding catastrophic nuclear accidents is naturally occurring radioactive materials including radon gas. Medical x-rays generally involve somewhat more radiation than average annual doses from background sources, although the dose varies depending on the procedure. Fallout from atmospheric nuclear weapons testing and day to day exposure from nuclear power facilities are much lower than normal background levels of radiation.

The health effects of ionizing radiation can be divided into those which occur with acute, high-level exposure, for example, in association with nuclear accidents, and those which occur with chronic low-level exposure. In general, the effects of acute exposure are well understood in relation to events such as the atomic bombing of Hiroshima and Nagasaki and the Chernobyl nuclear power plant disaster. The range of possible effects in these circumstances depends mainly on the dose of radiation and ranges from mild effects to death from complications of central nervous system, gastrointestinal or bone marrow effects. Survivors of the acute effects are also at risk for long term consequences, predominantly cancer.

There is much less certainty regarding the effects of chronic low-level exposure. While there is a low risk of cancer or genetic abnormalities, this appears to be small in comparison with other known risks such as that of dying in a motor vehicle accident. Radon gas is one exposure which is somewhat better understood.

Radon Gas

Radon is a radioactive gas produced by the decay of radium in the earth's crust. It is radon "progeny" - products of radioactive decay of radon gas - which are responsible for its health effects. Radon and its progeny are present naturally outdoors at levels which depend on the geological characteristics of a particular area. Radon gets into the air primarily from soil, but can also escape from water into the air. Indoor levels of radon tend to be higher than ambient outdoor levels for a number of reasons.

Radon gets into buildings through basements, in particular where there are loose gravel or dirt floors or cracks in the foundation, or where uranium or phosphate tailings have been used for fill. Radon can also come from contaminated building materials such as wallboard, bricks or stones used in construction. One other source is radon escaping from water used in bathing, clothes and dish washing and other domestic uses. In general groundwater (well water) contains greater concentrations of radon than surface water and domestic (private) wells contain greater concentrations than utility-run wells. While it is relatively easy for radon to get inside it is much more difficult for it to escape, particularly where ventilation is poor.

The main route of exposure to radon is inhalation from the air. Evidence that the general public is at risk from radon exposure is based primarily on extrapolation from studies of uranium miners. Although there are problems with generalizing from miners to the general population, it does appear that there is some risk of lung cancer from household exposure to radon.

Non-ionizing Radiation

a) Ultraviolet

The main source of ultraviolet radiation is the sun. Acute effects of this type of radiation include sunburn and eye irritation. Long term exposure has been clearly linked to cataracts and skin cancer. There is evidence that the risks of long term exposure are increasing because of chlorofluorocarbon (CFC) induced depletion of the stratospheric ozone layer, which protects the earth from excessive ultraviolet exposure.

b) Extremely Low Frequency (ELF)

Considerable controversy has arisen recently in both the medical and lay communities regarding the human health effects of ELF radiation. This type of non-ionizing radiation arises from, for example, electrical transmission lines, household electrical appliances and video display terminals (VDTs). A number of health studies have been done amongst children with leukemia, adults in general, and workers in electrical industries which have yielded mixed results. The World Health Organization and the International Radiation Protection Association (WHO/IRPA) have concluded that the existing research is not sufficiently conclusive to establish a cause and effect relationship between ELF radiation and human health effects. However, they have suggested that unnecessary exposure be avoided. Health studies in this area which are attempting to overcome the shortcomings of earlier studies are in progress in Canada and elsewhere.

4.0 Major Environmental Health Trends in the Region of Hamilton-Wentworth

4.1 Air Quality Trends

4.1.1 Outdoor Air

Data are available in both the Regional State of the Environment 1990 and the MOE 1988 Hamilton-Wentworth Air Quality reports up until the end of 1988. It should be noted that trends of certain air pollutants such as CO, NO2 and O3 are not available, as the AQI which measures them (as opposed to the Air Pollution Index (API) which tracked SO2 and particulate material) started in June 1988. The API still continues as a subindex of the AQI.

Total Suspended Particulates (TSP)

TSP come from a wide variety of sources: industrial emissions, vehicles, combustion of heating fuels, waste incineration, dust from roads and unpaved areas, mining/quarrying, and long-distance airborne transport of certain compounds such as sulphates and nitrates. TSP are complex substances, containing not only sulphates/nitrates but as well trace metals (nickel, chromium, lead and cadmium), carbon and related substances, and organic compounds such as PAHs (a number of which are known or suspected carcinogens). Measurements of TSP from the early 70s to 1988 reveal decreases in yearly averages until 1977 and then a uniform level from that point on.

Abatement of emissions from industrial sources such as Hamilton's steel industry and SWARU have resulted in a slow downward trend in both the absolute amount of emissions and their contribution to overall TSP levels. Research done in 1988 by several McMaster scientists on potential cancer risks associated with TSP levels indicated that urban TSP sources such as vehicle exhaust and residential heating oil had much greater carcinogenic potential than industrial emissions. The magnitude of such health effects is at present uncertain. Proximity to Hamilton's industrial core tends to result in a higher level of exposure to TSP.

Sulphur Dioxide (SO2)

Most emissions of SO2 arise from industrial sources, and a smaller proportion from fuel combustion. In general there has been a yearly downward trend in SO2 concentrations from 1970-1987, with an increase noted between 1987-88. Annual average SO2 concentration are well below the Ontario objective of 20 parts per billion (ppb). Hourly and 24-hourly objectives are much higher (250 and 100 ppb respectively) but fixed station monitoring of these levels is invariably below the objectives. Given that research in Hamilton has shown that children with asthma have significant increases in airway obstruction at levels as low as 20 ppb, the potential for acute health risks exists. SO2 contributes to the formation of acid aerosols, which have both human health and environmental consequences.

Total Reduced Sulphur (TRS)

TRS principally consists of hydrogen sulphide, which produces a characteristic "rotten egg" smell. The steel industry is the principal regional source for TRS, although the sewage treatment plant periodically contributes odours. Hydrogen sulphide is a respiratory and eye irritant, its odour being detectable at 10 ppb. Elevated levels are found most frequently in east Hamilton's Beach

Blvd. monitoring station. Hours above 10 ppb have shown consistent downward trends since the early 80s.

Carbon Monoxide (CO)

Most CO pollution comes from motor vehicle emissions, the remainder from other types of combustion of fossil fuels. Automobile emission standards are judged responsible for the fact that during 1988 measured CO concentrations never exceeded either the 1 hour or 8 hour air quality objectives (30 and 13 ppm respectively).

Nitrogen Oxide (NO2)

NO2 and other oxides of nitrogen are the products of high temperature combustion, principally from automobiles but as well from incinerators and power plants. Nitrogen oxides are respiratory irritants, they contribute to the formation of acid aerosols, and in the atmospheric presence of hydrocarbons and sunlight they react to form photochemical oxidants, principally ozone (see below). Levels measured in the region have remained relatively constant during the 1980s, and are consistently below the 1 hour and 24 hour air quality objectives.

Ozone (O3)

O3 is the principal photochemical oxidant found in urban "smog". Its concentration is dependent on the presence of nitrogen oxides, uncombusted hydrocarbons and sunlight, and is thus much more of a problem during the summer months. The one hour air quality objective of 80 ppb is based on the avoidance of damage to vegetation, with respiratory irritant effects (leading to airway obstruction and breathing difficulties) occurring at somewhat higher levels (>120 ppb). Although average annual O3 concentrations have been stable during the 1980s, MOE data indicate that maximum 1-hourly concentrations, and the number of hours/year above the air quality objective of 80 ppb, increased between 1985-88.

4.1.2 Trends in Indoor Air Quality

Information concerning indoor air quality in the region is limited. Major concerns include the effect of cigarette smoke on non-smokers, and the effect of "sick building syndrome" on office workers. Hopefully, ongoing studies will soon yield more extensive data on the potential health threats present in indoor air.

4.2 Water Quality Trends

4.2.1 Surface Water Quality (Lake Ontario)

Use of Surface Water for Drinking

Hamilton's water treatment system produces drinking water which regularly meets all of the health-related guidelines set by the Ministry of the Environment. These guidelines incorporate large safety margins for human exposure. Similarly, the City of Toronto's Department of Public Health recommended that:

> "residents...can continue to drink tapwater with reasonable assurance that it is not likely to cause harm or injury. The Department does not promote the use of alternatives to

> tapwater because of their inconsistent bacteriological quality, their variable chemical quality, and the lack of applicable standards to guarantee quality of product to the consumer." (The Quality of Drinking Water in Toronto, City of Toronto Department of Public Health, 1990, p.33)

As well, the recently released report, Toxic Chemicals in the Great Lakes and Associated Effects (as reported in the **Globe and Mail**, March 14, 1991), stated that cancer and birth defect rates around the lakes "are no higher than would be expected in any highly industrialized area of the country" and that tissue samples reveal levels of pollutants similar to those reported elsewhere in North America. The City of Toronto report did, however, identify six chemicals that were at or above "acceptable " levels. "Acceptable" concentrations of a carcinogen were defined as the estimated level of consumption (at 2 litres/day of water over a 70 year lifespan) which would result in less than a one in one million chance of developing cancer. A more comprehensive discussion of sources and trends is found in the State of the Environment 1990 report.

Use of Surface Water for Recreation

Although exposure to toxins may occur during recreational water activities, risk is probably minimal when compared with that associated with bacterial contamination (especially given that much past pollution is concentrated in lake and harbour sediments). The Department of Public Health Services regularly monitors bacterial contamination of beaches, and posts warnings when levels of contamination pose health risks. Recent MOE surveys which sampled and tested water quality at designated positions around the harbour noted both favourable and unfavourable measures of bacterial contamination. Storm water runoff was responsible for high levels of bacterial contamination following rainstorms. Regional efforts to control summer storm sewer runoff appear to be having an effect, as beach warning postings markedly decreased from 1985-89.

4.2.2 Groundwater Quality

Recent water quality testing has demonstrated several instances of groundwater contamination by bacteria, nitrates and sodium, and to a lesser extent, petroleum products such as gasoline. The contribution to these problems of increasing development in rural areas is unclear. The Sustainable Development Task Force autumn 1990 public participation program revealed that groundwater quality was an important public concern.

In 1986, the region conducted a health and water quality study in the Parkway Belt (Pleasant View) area of Dundas. This study found that the majority of wells were unsafe from the point of view of bacterial contamination. It also documented elevated rates of gastrointestinal symptoms which were probably related to the bacterial contamination. The source of bacterial contamination in many cases appeared to be inadequate sewage disposal in septic systems as well as poor well maintenance.

More recently, in 1990 water quality surveys in Millgrove and other areas of Flamborough indicated that similar but less severe problems existed in these areas. In Millgrove about one quarter of wells were contaminated with bacteria, thirty per cent had elevated sodium levels and over 5 per cent had elevated nitrate levels. In many cases these results appeared to have resulted from inadequate well maintenance, although some communities expressed concern about the potential for an increase in groundwater contamination accompanying residential development and an attendant increase in the density of septic systems in the area.

Although well water contamination with petroleum products has not yet been documented on the same scale as the above problems, gasoline contamination could become a major issue in the future. With regard to other contaminants, one survey of indoor radon levels in Canadian homes revealed that 1.7 per cent of Toronto homes exceeded U.S. National Research Council (NRC) remedial action levels, whereas 0.9 per cent exceeded the U.S. Environmental Protection Agency (USEPA) levels. This is in contrast to 30 and 20 per cent respectively of homes exceeding these levels in Elliott Lake, Ontario. It is worth noting that these action levels are considerably higher than average levels and their validity has been questioned. No direct information on Hamilton is available but considering its geologic similarity to Toronto, levels would probably be similar.

4.3 Trends in Threats from Contaminated Sites

Information on contaminated sites in the region comes from the State of the Environment Report 1990 (SOER) as well as the Terraqua Report and related commentary. Although the SOER notes that there is no comprehensive list of contaminated sites in the region and virtually any former industrial site could be contaminated with a wide variety of chemicals, three sites have been "publicly identified" as contaminated. These include the Lax site, the Hamilton Street Railway (HSR) site and the Upper Ottawa Street Landfill.

The Lax site is associated with heavy metal contamination and there is concern regarding runoff into the harbour from rain and groundwater. The HSR site is a former foundry and fuel storage area as well as being the location of several electrical transformers. Concerns relate to heavy metals, fuels and PCBs. The Upper Ottawa Street landfill may be contaminated with a wide range of industrial chemicals dumped there until 1980 when the site was closed. A health study of workers and residents living near the landfill found consistent relationships between intensity of exposure to the site and respiratory symptoms, skin irritation, mood changes, headaches and dizziness.

The Terraqua report and related commentary by the Solid Waste Subcommittee of the Regional Chairman's Advisory Committee on Environmental Issues identify ten sites, all of which are closed landfills for which the region has recently become responsible. These are located at Binbrook, Glanford, Brampton St., West Hamilton, Dundas, Stoney Creek, Ancaster, Beverly, Upper Ottawa Street and Edgewood (Flamborough). In general, there are serious concerns about the potential for ground and surface water contamination from these sources. Leachate from landfills tends to be much more concentrated with respect to toxic organic compounds and heavy metals than domestic sewage. Old landfills such as these typically do not have liners or leachate collection systems and as a result there is greater potential for contamination of nearby water.

The Solid Waste Subcommittee (SWS) recommended more intensive monitoring of ground and surface water in the vicinity of these sites than the Terraqua consultants. The SWS noted that there were three factors which complicate monitoring of leachate from landfills: the large variety of chemical substances which could be present, the lack of specific documentation of what chemicals are present at any site and the considerable variation in the composition of leachate from site to site and from time to time at any given site. These factors mean that both the frequency of monitoring and the number of parameters measured may need to be increased. Existing and past monitoring have been too "hit and miss" to be capable of demonstrating consistent trends with any confidence. There is at least one site (Beverly) where groundwater contamination from the landfill has been documented.

One encouraging note mentioned in the SOER is that a household hazardous waste collection program in 1989 was successful in collecting over 250 forty-five gallon drums of hazardous liquids, as well as batteries and propane cylinders which otherwise would have contributed to toxic leachate at regional landfill sites. Although there is no comprehensive list of contaminated sites in Hamilton-Wentworth, Niagara Falls, Ontario has established a comprehensive geographic information system which locates these sites as well as areas of contaminated groundwater. This could serve as a model for other municipalities.

5.0 Conclusions and Implications for the Future

1. **Science has a finite capacity to answer questions regarding the human health effects of environmental exposures.** Given the large number of potentially hazardous environmental contaminants, definitive answers regarding human health effects in relation to all of these cannot reasonably be expected. Determining what people are exposed to, measuring their exposures and relating their exposures to health outcomes are problematic. Different sectors of society respond to this uncertainty in different ways. Industries, for example, (eg. tobacco or asbestos companies) are likely to exaggerate the uncertainty surrounding scientific evidence which links their products with adverse health effects in order to downplay the apparent risks. On the other hand, uncertainty tends to heighten the public's perception of the risks associated with specific environmental exposures.

2. **Although imperfect, scientific evidence may be used to broadly define environmental health priorities.** Some environmental health threats are clearly more important than others with respect to public health. Stratospheric ozone depletion, second hand tobacco smoke and bacterial contamination of groundwater, for example, are much more important than sodium in groundwater and chemical residues in foods. Other environmental health threats affect specific groups more than others. Many air pollutants, for example, primarily affect those with underlying respiratory disease such as asthma, and nitrates in groundwater are primarily hazardous to infants. In many other cases, the health effects of environmental exposures are impossible to quantify relative to other hazards at the present time. The effects of chemical leachate from landfills, for example, are poorly understood.

3. **Responsibility for establishing environmental health priorities and for remediating environmental degradation rests with different sectors of society whose perceptions of various risks may differ considerably.** There is often an inequitable distribution of the benefits and risks of the various types of human activity which result in environmental contamination. This inequity puts different sectors of society at odds with respect to their perceptions of the nature and magnitude of the risks, as well as the assignment of responsibility for mitigating these risks. The public, for example, may perceive a particular industrial site as posing significant health risks, while government and industry experts provide assurances that the risks are within an acceptable range. In some cases this means that the public forces government to allocate resources inappropriately to high profile environmental concerns which in reality pose little hazard relative to other less visible risks. On the other hand, the public is increasingly reluctant to accept decisions which have been made by "experts" in isolation. There is a growing challenge not simply to educate the public by providing them with scientific information, but to integrate scientific evidence, uncertainty and popular perceptions of risk in the determination of environmental health priorities.

There is increasing recognition that individual citizens and industry do, none the less, share responsibility for environmental contamination. While attention has often focused on industrial sources of air pollution, for example, vehicle exhaust is now recognized as being at least as important; and while there is considerable public concern about industrial contamination of land with heavy metals, disposal of household batteries is known to contribute significantly to this problem as well.

4. There will be increasing public pressure to approach environmental issues proactively rather than reactively and to incorporate an understanding of the global dimensions of these problems into policy decisions. Approaches to dealing with environmental contamination include elimination of the source either directly (eg. legislation banning smoking in public places or prohibiting the manufacture of substances which deplete the stratospheric ozone layer), or indirectly (eg. economic incentives such as high taxes on tobacco products or gasoline pricing which penalizes the use of leaded gasoline); isolation of the contaminant from people (eg. segregating industrial land use from residental use); protection of people from the contaminant (eg. use of personal protective equipment in various occupations); and treatment of the consequences of contamination (eg. treating more frequent childhood respiratory infections or lung cancer resulting from exposure to second hand smoke). Proactive approaches which eliminate the source of contamination have the advantages of preventing both the human health effects and broader ecological effects of environmental contamination as well as avoiding the often technically difficult task of after-the-fact remediation of the effects of environmental contamination.

Scientists, government, and the public are increasingly recognizing that there is a global dimension to both the sources and effects of environmental contaminants. A considerable proportion of the air pollutants present in the region, for example, have been transported here from industrial areas of the United States and contribute to air pollution related health problems in the region. At the same time, Hamilton-Wentworth contributes significantly to the global burden of air pollutants such as greenhouse gases, which have been linked to global atmospheric warming, and substances which deplete the stratospheric ozone layer, especially chlorofluorocarbons (CFCs). Similarly, low-level chemical contamination of the Great Lakes results from industrial discharges both within the region and elsewhere. The global social, health and economic consequences of environmental contamination could be much more significant than any local effects.

5. The role of municipal government in environmental health is increasing. Regional departments such as the Planning and Development Department, the Engineering Department and the Department of Public Health Services, have firm historical roots in environmental health activities such as land use planning, sewer construction and sewage treatment and control of food- and water-borne disease. Pressures from the public and from other levels of government are forcing municipal government to devote more attention to environmental health. Local concerns include groundwater quality, indoor air pollution (principally from tobacco smoke), low-level chemical contamination of municipal water obtained from the Great Lakes, outdoor air pollution from industrial and vehicle emissions, and chemical leachate from landfills and other contaminated sites.

In addition to its own departments, the region can draw on expertise from other levels of government, including the Ontario Ministry of the Environment and federal agencies such as the Canadian Centre for Occupational Health and Safety and the Canadian Centre for Inland Waters. It also has access to medical and other scientific expertise at McMaster University, including community health oriented entities such as the Health Priorities Analysis Unit, and innovative interdisciplinary groups such as the joint McMaster - University of Toronto Institute for Environment and Health.

Selected References

Environmental Health Risks and Policy

Gibson B. Human Health Risk. In State of the Environment 1990. Hamilton: Planning and Development Department, Region of Hamilton-Wentworth, November 1990, pp 125-127.

Green Choices, Hard Choices. The Economist. March 16, 1991. p 11.

Health and Welfare Canada. Health Risk Determination. Ottawa: Minister of Supply and Services Canada, 1990.

Kasperson RE. Six Propositions on Public Participation and Their Relevance for Risk Communication. Risk Analysis 1986 6(3):275-281.

Ontario Ministry of Health. Annual Report 1981-82, A Century of Caring. 1982

Purdom, Walter. Environmental Health. 1971

Rosen, George. A History of Public Health. 1958

Slovic P. Perception of Risk. Science 1987 236:280-285.

Workshop to Discuss the Health-Environment Issues Within the Context of the Federal Government's Green Plan. Health Dimensions of Environmental Issues. Ottawa: Canadian Public Health Association, 1990, p 8.

Workshop on Health Aspects of Environmental Impact Assessment. Human Health and Environmental Impact Assessment. Ottawa: Canadian Public Health Association, 1989, pp 6-8

Groundwater Quality

Arbuckle TE, Sherman GJ, Corey PN, Walters D, Lo B. Water Nitrates and CNS Birth Defects: A Population-Based Case-Control Study. Archives of Environmental Health 1988 43(2):162-167.

Calabrese EJ, Tuthill RW. The Massachusetts Blood Pressure Study, Parts 1-4. Toxicology and Industrial Health 1985 1(1):1-43.

Cherry JA. Groundwater Contamination By Petroleum Products. Paper presented at the Twelfth World Petroleum Congress, Houston, Texas, April 26-May 1, 1987.

Cutler JJ et al. Childhood Leukemia in Woburn, Massachusetts. Public Health Reports 1986 101(2):201-205.

Dorsch MM, Scragg RK, McMichael AJ, Baghurst PA, Dyer KF. Congenital Malformations and Maternal Drinking Water Supply in Rural South Australia: A Case-control Study. American Journal of Epidemiology 1984 119(4):473-486.

Fit to Drink. Consumer Reports, January 1990, 27-40.

Fraser P, Chilvers C, Beral V, Hill MJ. Nitrate and Human Cancer: A Review of the Evidence. International Journal of Epidemiology 1980 9(1):3-11.

Hallenbeck WH, Brenniman GR, Anderson RJ. High Sodium in Drinking Water and Its Effect on Blood Pressure. American Journal of Epidemiology 1981 114(6):817-826.

Johnson CJ et al. Fatal Outcome of Methemoglobinemia in an Infant. Journal of the American Medical Association 1987 257(20):2796-2797.

Johnson CJ, Kross BC. Continuing Importance of Nitrate Contamination of Groundwater and Wells in Rural Areas. American Journal of Industrial Medicine 1990 18:449-456.

Korch GC. Sodium Content of Potable Water: Dietary Significance. Journal of the American Dietetic Association 1986 86(1):80-83.

Logue JN et al. Investigation of Potential Health Effects Associated with Well Water Chemical Contamination in Londonderry Township, Pennsylvania, USA. Archives of Environmental Health 1985 40(3):155-160.

Okun DA. Water and Waste Disposal. In Last JM (ed), Maxcy Rosenau Public Health and Preventive Medicine, Norwalk, Connecticut: Appleton-Century-Crofts, 1986, pp 815-817.

Ontario Ministry of the Environment. Ontario Drinking Water Objectives. Toronto: Ontario Ministry of the Environment, 1983, pp. 9-11.

Shy CM. Chemical Contamination of Water Supplies. Environmental Health Perspectives 1985 62:399-406.

Tuthill RW, Calabrese EJ. Drinking Water Sodium and Blood Pressure in Children: A Second Look. American Journal of Public Health 1981 71(7):722-729.

Water Resources Branch, Ontario Ministry of the Environment. Water Wells and Ground Water Supplies in Ontario. Toronto: Ontario Ministry of the Environment, 1987, pp. 54-55.

Willett WC. Drinking Water Sodium and Blood Pressure: A Cautious View of the 'Second Look'. American Journal of Public Health 1981 71(7):729-732.

Landfill and Contaminated Properties

Buffler PA, Crane M, Key MM. Possibilities of Detecting Health Effects by Studies of Populations Exposed to Chemicals from Waste Disposal Sites. Environmental Health Perspectives 1985 62:423-456.

Grandjean P. Diseases Associated with Metals. In Last JM (ed), Maxcy-Rosenau Public Health and Preventive Medicine, Norwalk, Connecticut: Appleton-Century-Crofts, 1986, pp 587-615.

Hertzman C, Hayes M, Singer J, Highland J. Upper Ottawa Street Landfill Site Health Study. Environmental Health Perspectives 1987 75:173-195.

Levine R, Chitwood DD. Public Health Investigations of Hazardous Organic Chemical Waste Disposal in the United States. Environmental Health Perspectives 1985 62:415-422.

Lipscomb JA et al. A Follow-up Study of the Community Near the McColl Waste Disposal Site. (Abstract). Presente at the Second Annual Meeting of the International Society for Environmental Epidemiology, Berkeley, California, August 12-15, 1990.

Mendell MJ. Interpretation of Self-Reported Symptom Data in Settings with Likely Over-Reporting due to Environmental Worry. (Abstract). Presented at the Second Annual Meeting of the International Society for Environmental Epidemiology, Berkeley, California, August 12-15, 1990.

Meyer CR. Liver Dysfunction in Residents Exposed to Leachate from a Toxic Waste Dump. Environmental Health Perspectives 1983 48:9-13.

Neutra R, Lipscomb A, Satin KP, Shusterman D. Factors Which Might Contribute to Higher Symptom Rates Sometimes Observed Around Hazardous Waste Sites. (Abstract). Presented at the Second Annual Meeting of the International Society for Environmental Epidemiology, Berkeley, California, August 12-15, 1990.

Rachlis MM. A Randomized Controlled Trial of Soil Removal from the South Riverdale Neighbourhood of Toronto. (Master's Thesis). Hamilton: McMaster University, 1987.

Shusterman D, Lipscomb J, Neutra R, Satin K. Symptom Prevalence and Odor-Worry Interaction near Hazardous Waste Sites. (Abstract). Presented at the Second Annual Meeting of the International Society for Environmental Epidemiology, Berkeley, California, August 12-15, 1990.

Taylor SM et al. The Psychosocial Impacts of Exposure to Environmental Contaminants in Ontario - A Feasability Study - Final Report. Hamilton: McMaster University, May, 1989.

Radiation

Adelstein SJ. Uncertainty and Relative Risks of Radiation Exposure. Journal of the American Medical Association 1987 258(5):655-657.

Collman GW, Loomis DP, Sandler DP. Radon-222 concentration in groundwater and cancer mortality in North Carolina. International Archives of Occupational and Environmental Health

1988 61:13-18.

Council on Scientific Affairs. Radon in Homes. Journal of the American Medical Association 1987 258:668-672.

Crawford-Brown DJ, Cothern CR. A Bayesian Analysis or Scientific Judgement of Uncertainties in Estimating Risk Due to 222Rn in U.S. Public Drinking Water Supplies. Health Physics 1987 53(1):11-21.

Cross FT, Harley NH, Hofmann W. Health Effects and Risks From 222Rn in Drinking Water. Health Physics 1985 48(5):649-670.

Finch SC. Acute Radiation Syndrome. Journal of the American Medical Association 1987 258(5):664-667.

Fit to Drink. Consumer Reports, January 1990:27-34.

Frank AL, Slesin L. Nonionizing radiation. In Last JM (ed), Maxcy-Rosenau Public Health and Preventive Medicine, Norwalk, Connecticut: Appleton-Century-Crofts, 1986, pp. 714-726.

Hess CT, Michel J, Horton TR. The Occurrence of Radioactivity in Public Water Supplies in the United States. Health Physics 1985 48(5):533-586.

Ishii EK et al. Is it Possible to Assess the Health Effects of Electromagnetic Radiation. (Abstract). Presented at the second annual meeting of the International Society for Environmental Epidemiology, Berkeley, California, August 13-15, 1990.

Radford EP. Ionizing Radiation. In Last JM (ed), Maxcy-Rosenau Public Health and Preventive Medicine, Norwalk, Connecticut: Appleton-Century-Crofts, 1986, pp 726-734.

Radford EP. Potential Health Effects of Indoor Radon Exposure. Environmental Health Perspectives 1985 62:281-287.

Scanlan L. The Killing Fields. Harrowsmith Magazine 1991, Jan/Feb, No. 95:32-42.

Tenforde TS. Biological Interactions and Human Health Effects of Extremely Low Frequency Magnetic Fields. In Wilson BW, Stevens RG, Anderson LE (eds), Extremely Low Frequency Electromagnetic Fields: The Question of Cancer, Columbus: Battelle Press, 1990, pp. 304-309.

Trends in Groundwater Quality

Cunningham I. A Health and Water Quality Study of the Parkway Belt Subdivision in the Town of Dundas. Department of Health Services, Regional Municipality of Hamilton-Wentworth, February, 1987.

Planning and Development Department, Regional Municipality of Hamilton-Wentworth, Regional Planning Branch. Chairman's Task Force on Sustainable Development Public Participation Program, Autumn 1990 - Summary of Findings. Regional Municipality of Hamilton-Wentworth, January 23, 1991.

Planning and Development Department, Regional Municipality of Hamilton-Wentworth. State of the Environment 1990. Regional Municipality of Hamilton-Wentworth, October, 1990, p. 43.

Radford EP. Potential Health Effects of Indoor Radon Exposure. Environmental Health Perspectives 1985 62:281-285.

Scott F. Report to Health and Social Services Committee on Millgrove Drinking Water Study. Regional Municipality of Hamilton-Wentworth, October 30, 1990.

Trends in Contaminated Sites

Baetz R, Varangu L, Waidlaw C. Recommendations Resulting From an Independent Review of the Terraqua Report. Prepared for the Chairman's Advisory Committee on Environmental Issues, September 13, 1990.

Boyle B, Blackport R. An Evaluation of the Existing Environmental Monitoring Programs at Eight Closed Landfill Sites in the Region of Hamilton-Wentworth. Waterloo: Terraqua Investigations, 1989.

Hertzman C, Hayes M, Singer J, Highland J. Upper Ottawa Street Landfill Site Health Study. Environmental Health Perspectives 1987 75:173-195.

Planning Department, Regional Municipality of Hamilton-Wentworth. State of the Environment 1990. Hamilton: October 1990.

HAMILTON PUBLIC LIBRARY
3 2022 21293050 3